

# The extreme radio emission of PSR B0656+14

Patrick Weltevrede, UvA

Ben Stappers, ASTRON

Geoff Wright, Sussex

Joanna Rankin, Vermont

# Overview

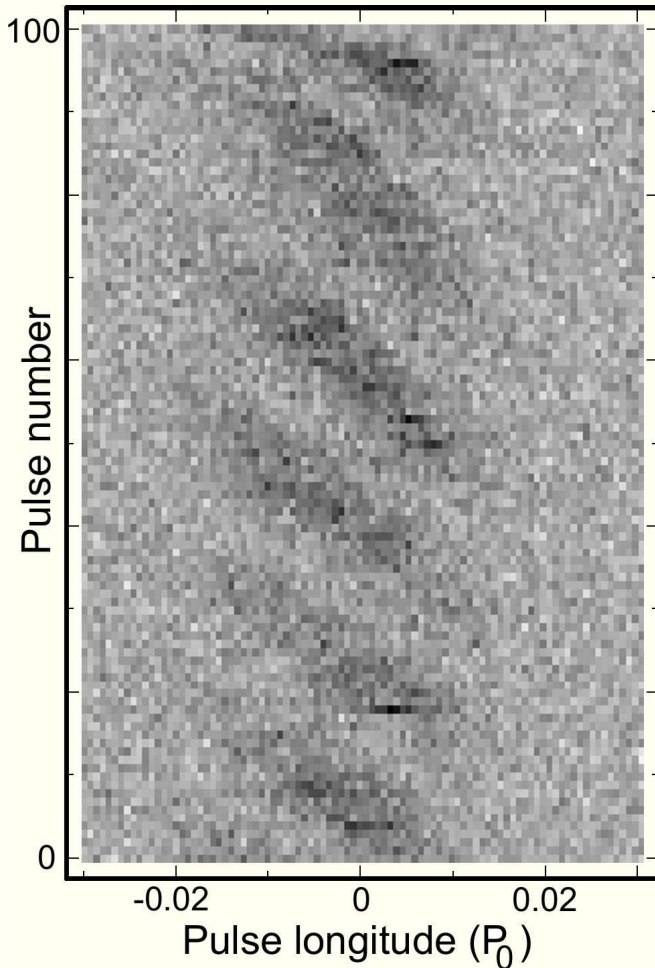
- Introduction
- The single pulses of PSR B0656+14:  
**Extreme bright and spiky emission**
- Comparison with giant pulses and RRATs
- Conclusion

# One of the “Three Musketeers”

- **Middle aged (111,000 years old)**  
( $P = 0.39$  sec and  $\dot{P} = 5.5 \times 10^{-14}$ )
- **Nearby (288 pc)**
- **Pulsed and thermal high energy emission**

# Drifting subpulse survey

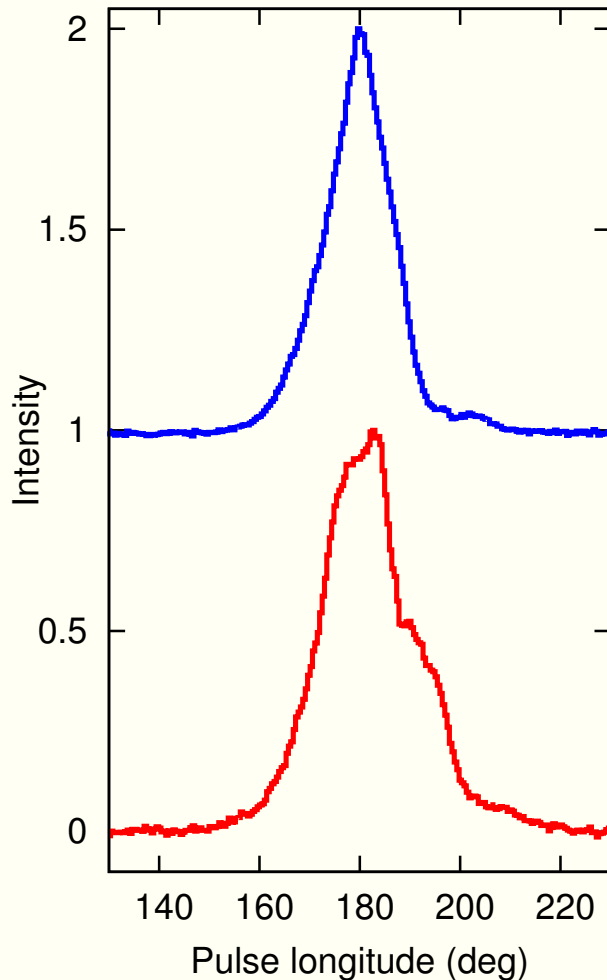
(Weltevrede et al. 2006)



**We observed single pulses of  
187 pulsars with WSRT at 21 cm  
(see poster P10).**

# PSR B0656+14: Giant pulses?

Found a strong pulse far away from profile centre



## Follow-up observations:

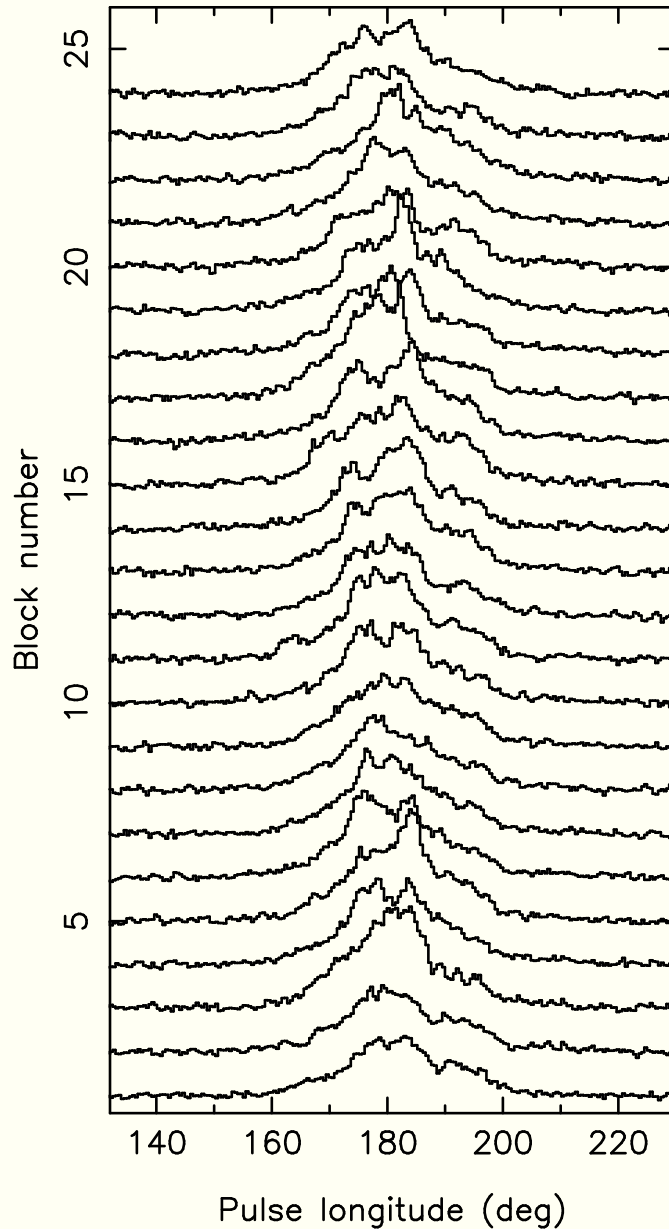
2.0h WSRT @ 1380 MHz

1.5h Arecibo @ 1575 MHz

4.5h Arecibo @ 327 MHz

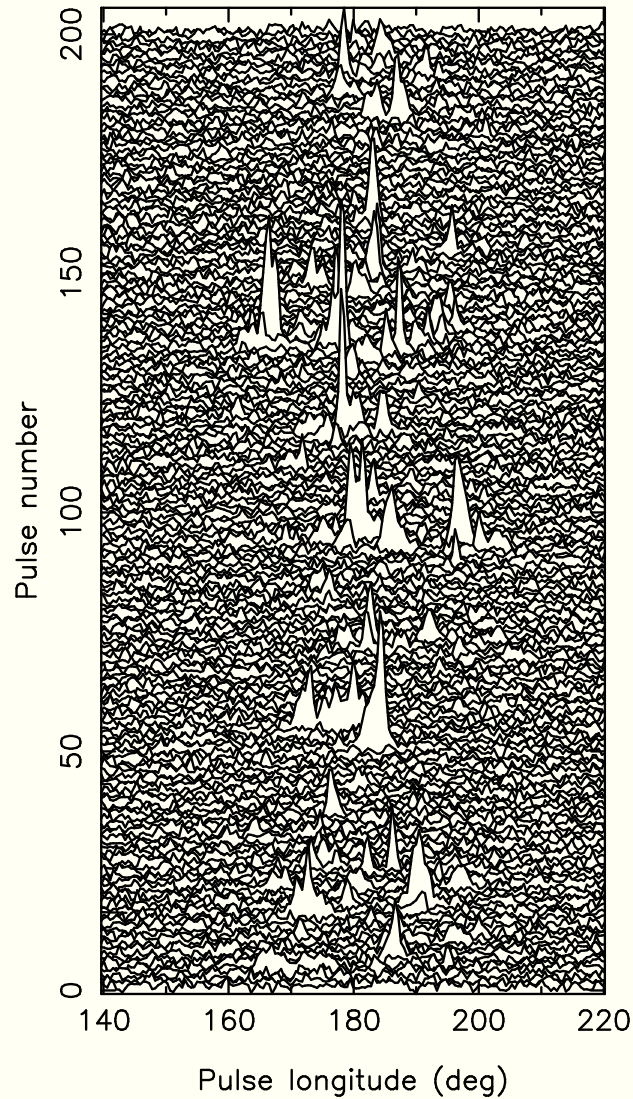
# Profiles of 1000 successive pulses

(327 MHz)



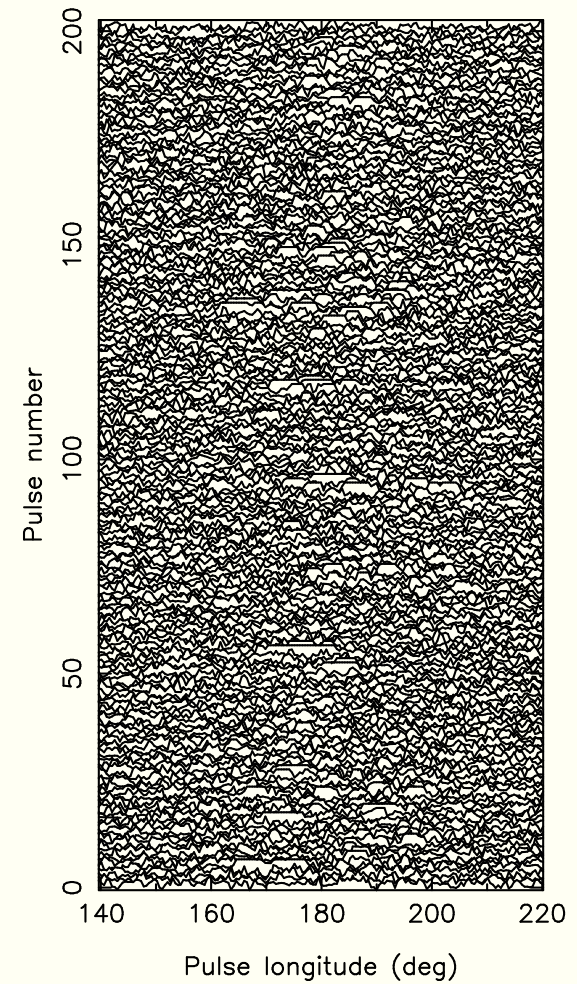
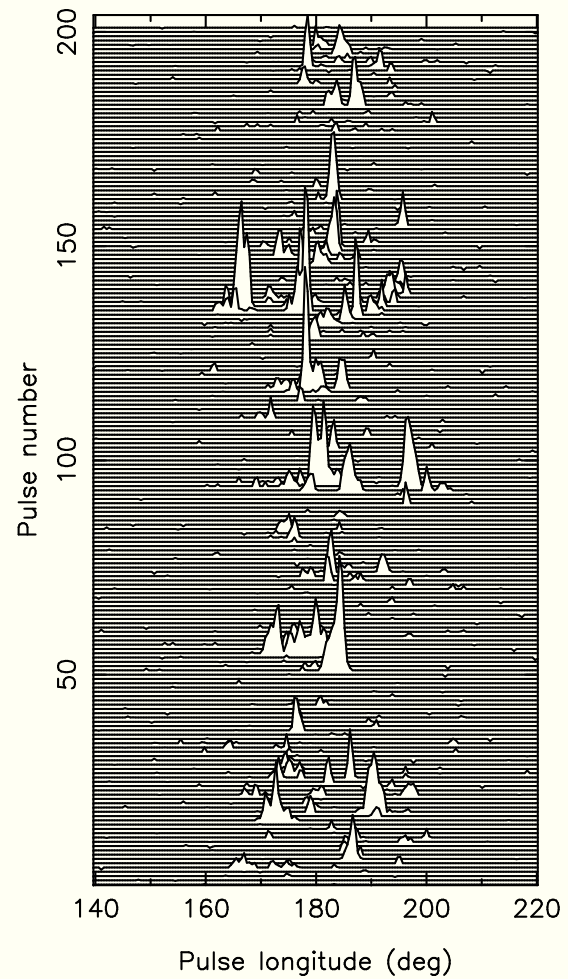
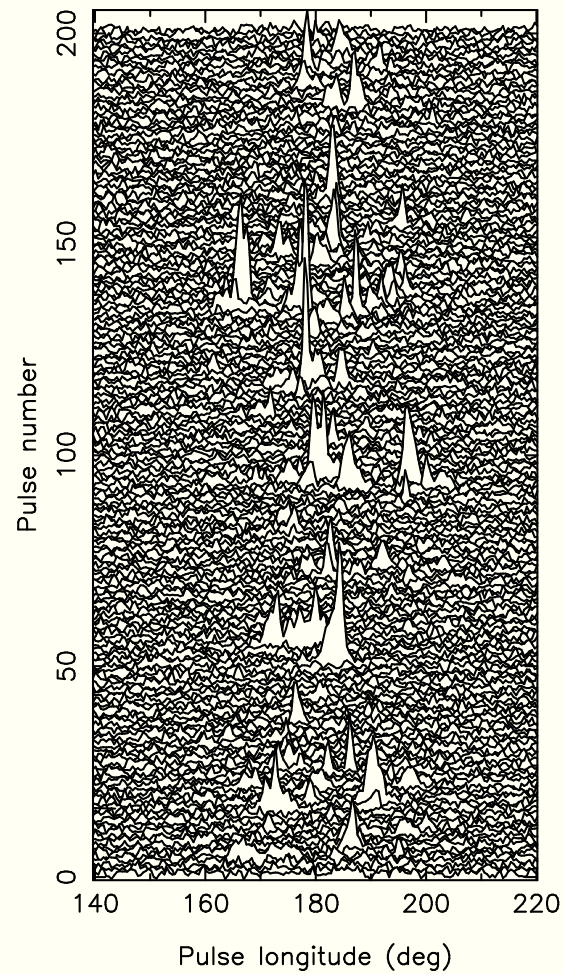
**Need at least 25,000 pulses to obtain 'true' profile.**

# Spiky emission



**PSR B0656+14 shows narrow and powerful bursts of radio emission.**

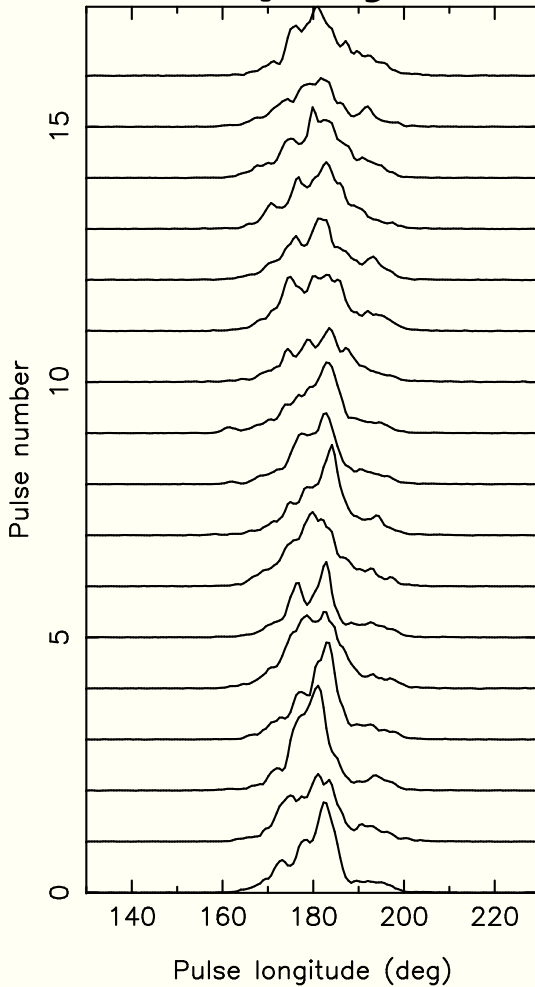
# Separated stacks



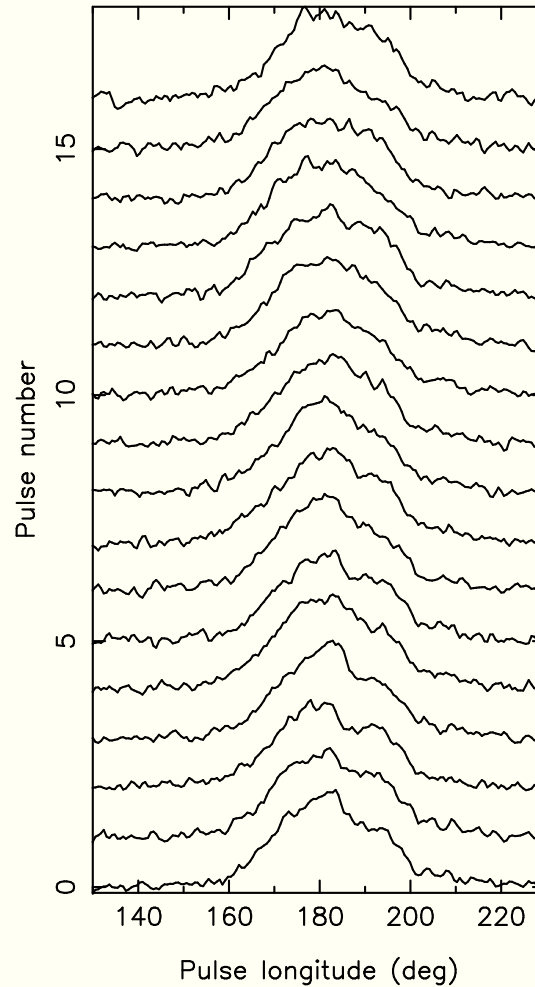


# Separated profiles

**spiky**



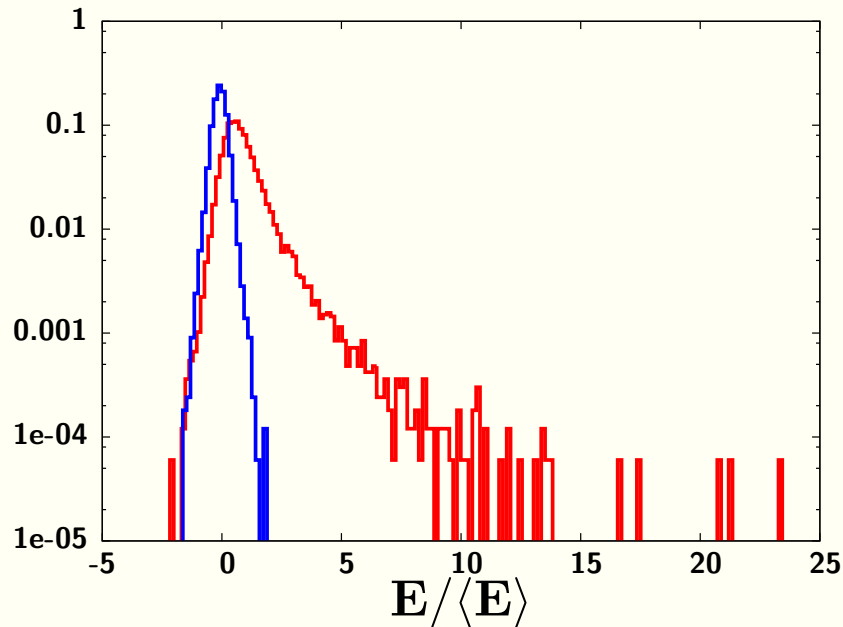
**weak**



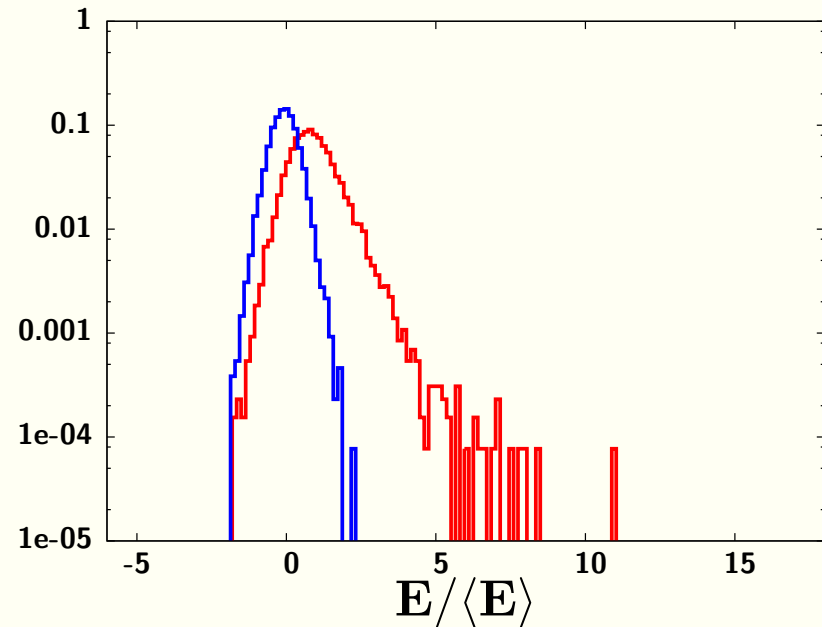
- **Profile weak emission broader**
- **Profile unstable because of spiky emission**
- **Slow spikiness evolution**

# Pulse-energy distribution

327 MHz



1380 MHz

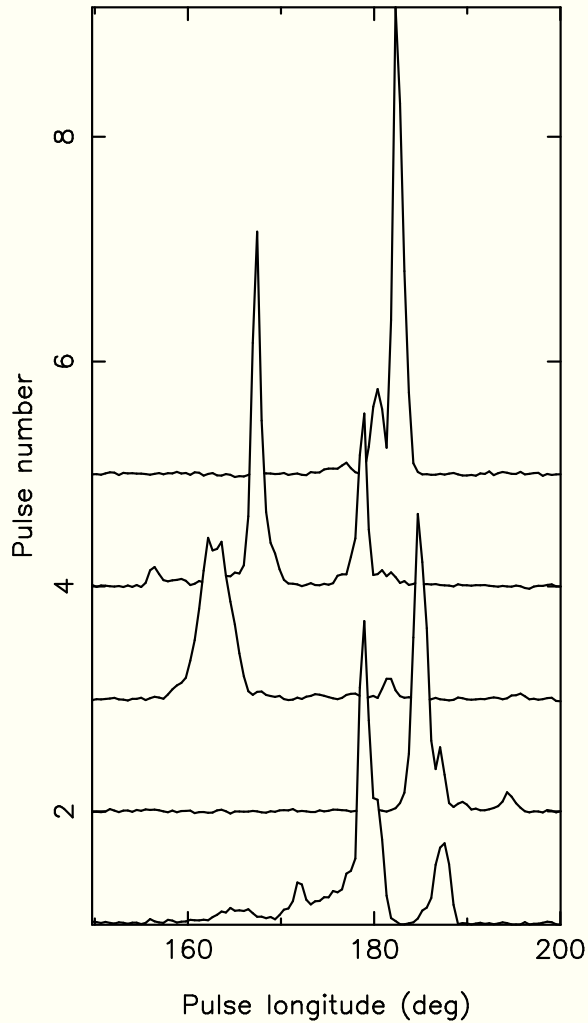


**Brightest pulse @ 327 MHz: 116  $\langle E \rangle$**

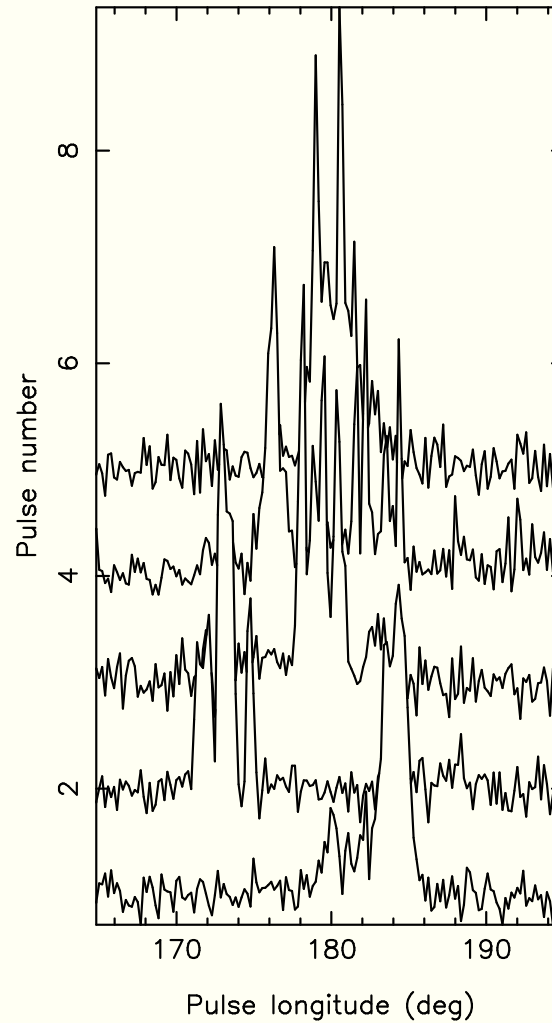
**No evidence for powerlaw tail**

# Brightest pulses

327 MHz

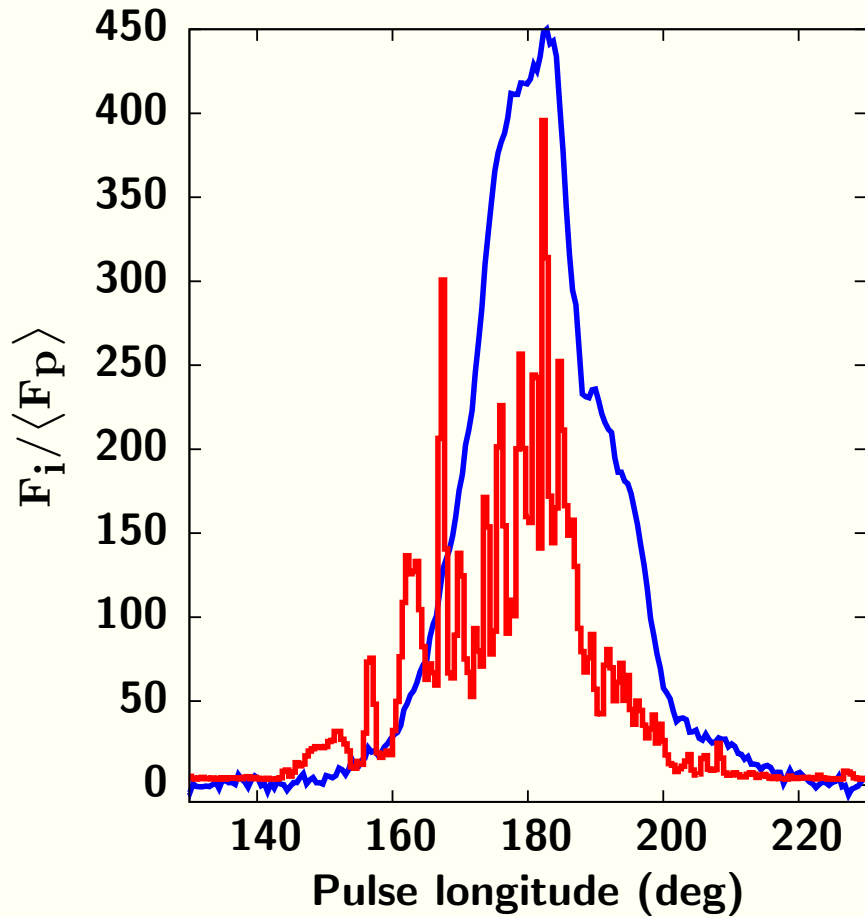


1380 MHz



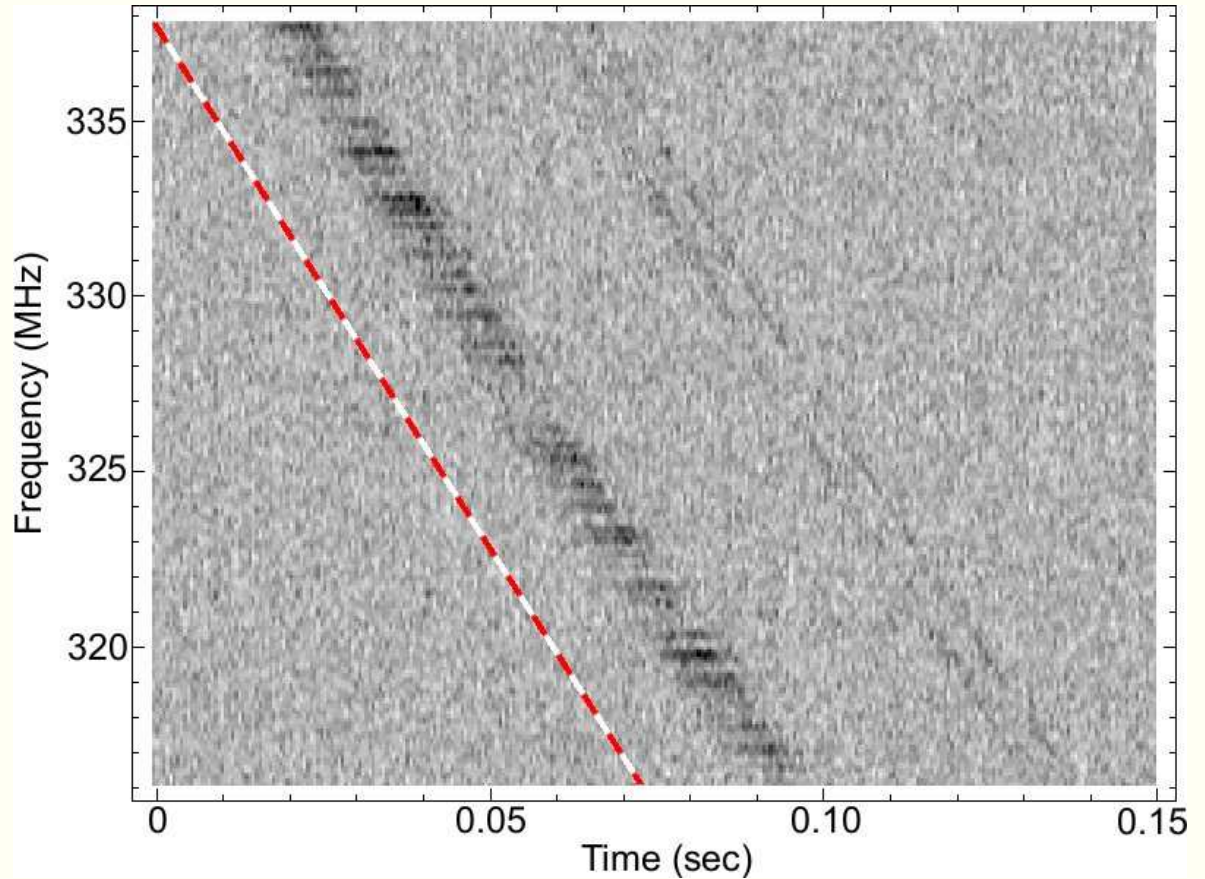
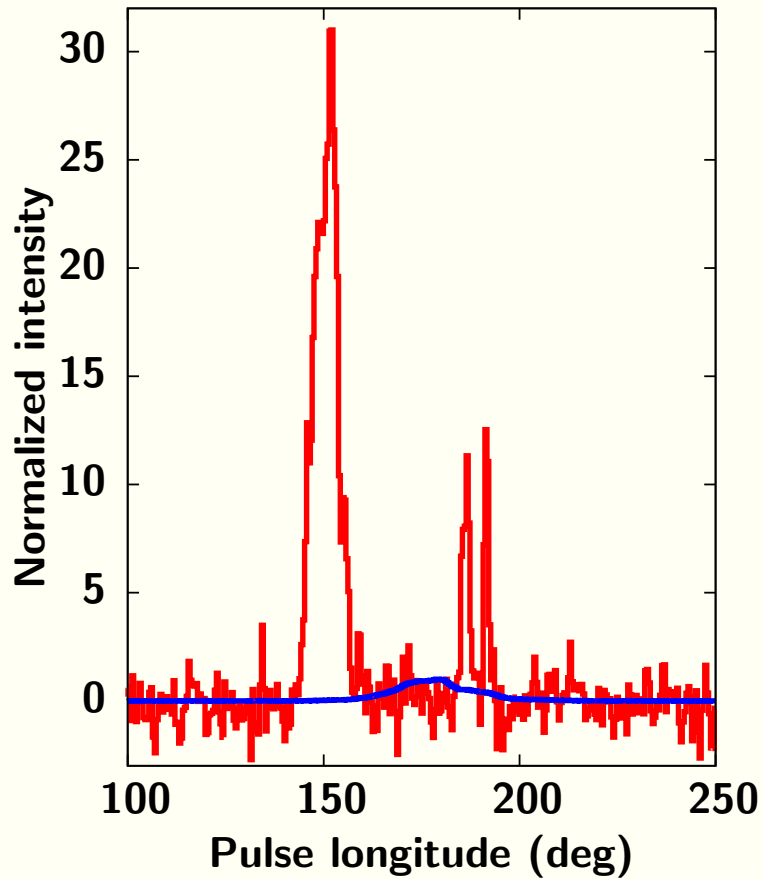
- **Broad ( $\sim 2$  ms)**
- **Not confined**
- **$\sim 10$  ms quasi-periodicity**
- **1 ms microstructure**

# Very high peak fluxes



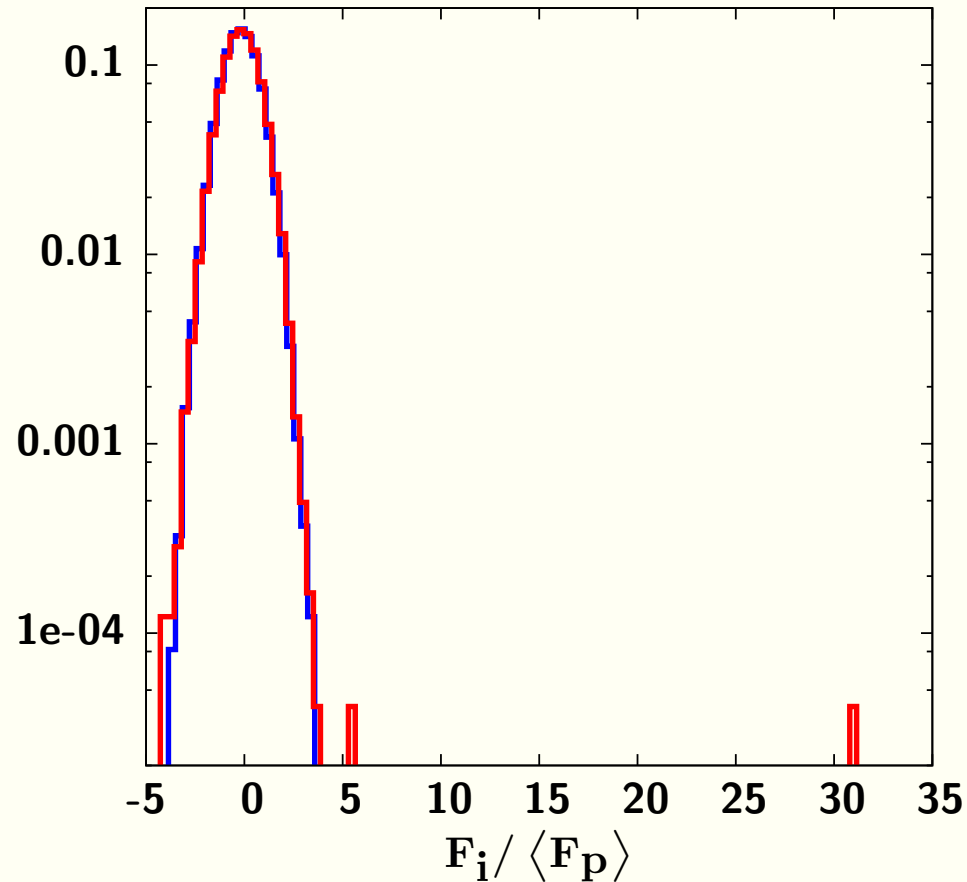
- **Peak flux up to 420 times average**

# Exceptional pulse



**Pulse  $12.5 \times$  brighter & peak flux  $2000 \times$  stronger**

# Peak-fluxes at leading side profile



**Distribution has extreme long tail  
(or is completely undersampled).**

# Does PSR B0656+14 emit giant pulses?

The bursts of PSR B0656+14:

- are too broad
- are not confined
- have no power-law energy distribution
- are NOT associated with high energy emission
- Magnetic field at light cylinder is not very high

# Bursts of PSR B0656+14 and RRATs are similar

- Brightest burst as luminous as 4/11 RRATs
- Peak flux brightest burst  $420 > 200$  average
- Only one burst per hour would be detectable if PSR B0656+14 would be at 2.88 kpc instead of 0.288 kpc.
- $P$  and  $\dot{P}$  in range RRATs
- X-ray spectrum of PSR B0656+14 is like RRAT J1819–1458 consistent with a cooling, middle aged neutron star (Reynolds et al. 2006)



# Conclusions

**If PSR B0656+14 is a true prototype for an RRAT, then it will also be found for RRATs that**

- they emit much weaker pulses**
- their pulses integrate to a much wider profile than the width of the individual bursts**
- many pulses are needed to get a stable profile**